2003 *Microcystis aeruginosa* spatial distribution study in San Francisco Bay Estuary

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Introduction

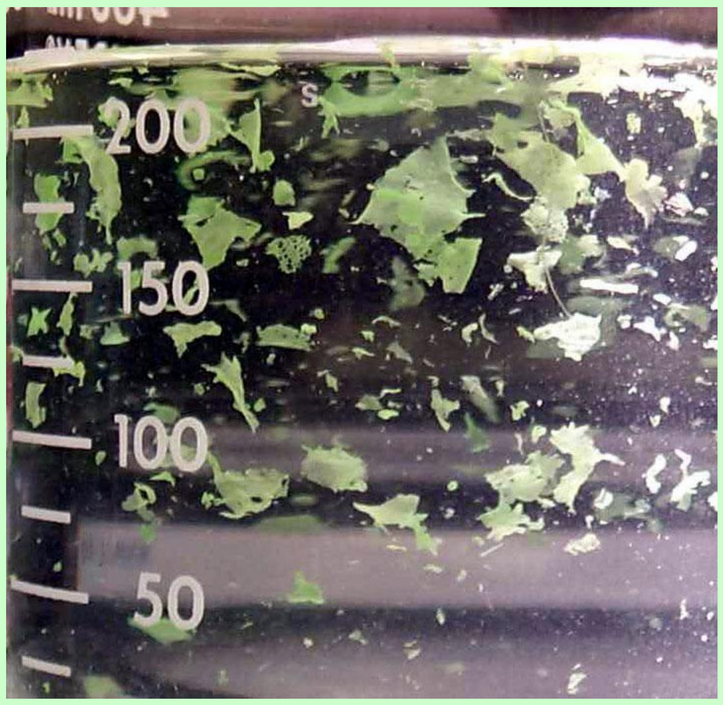
Every year since 1999, *Microcystis aeruginosa* blooms have spread during the late summer and early fall throughout the central and southern Delta. A special study was conducted in 2003 to determine what sampling techniques could be employed to collect *M. aeruginosa* and map its spatial distribution. A follow-up study was then conducted at 14 locations of varying habitat types to determine the presence and potential toxicity of an *M. aeruginosa* bloom.

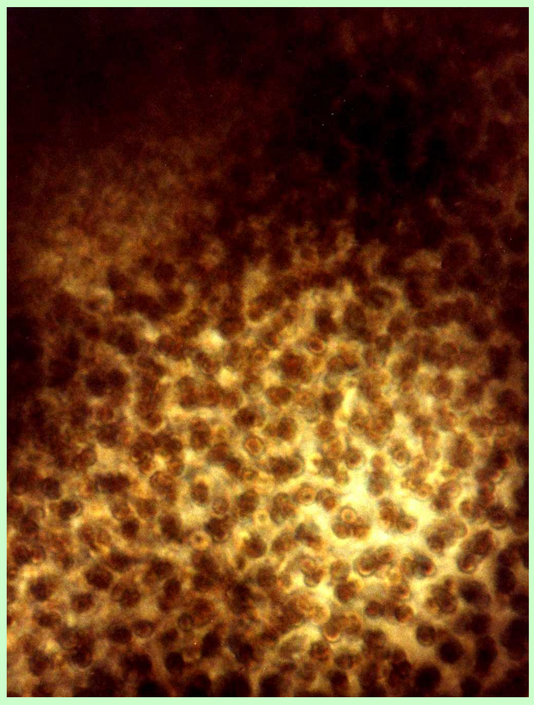
What is Microcystis?

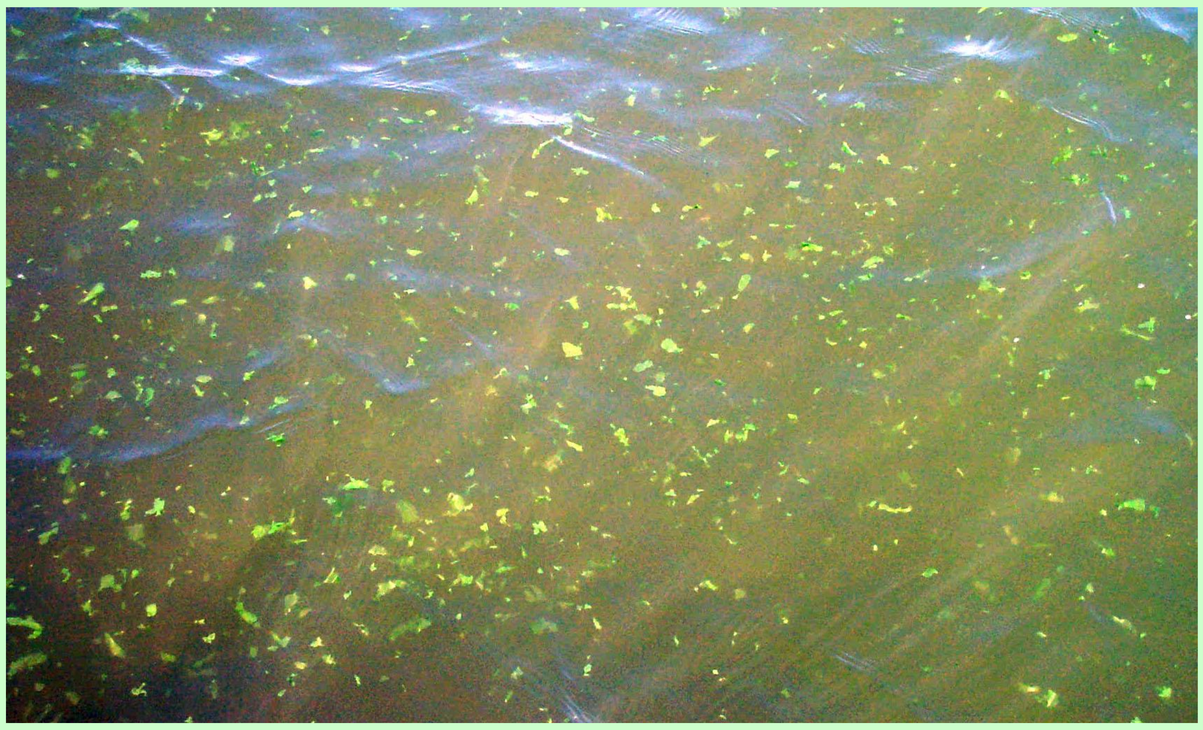
Microcystis aeruginosa is a common species of blue-green algae or cyanobacteria. Individual cells of this species tend to aggregate together and form colonies, which are held together by mucilage and can consist of thousands of individual cells. *M. aeruginosa* cells contain gas vacuoles which enable colonies to float near the water surface.

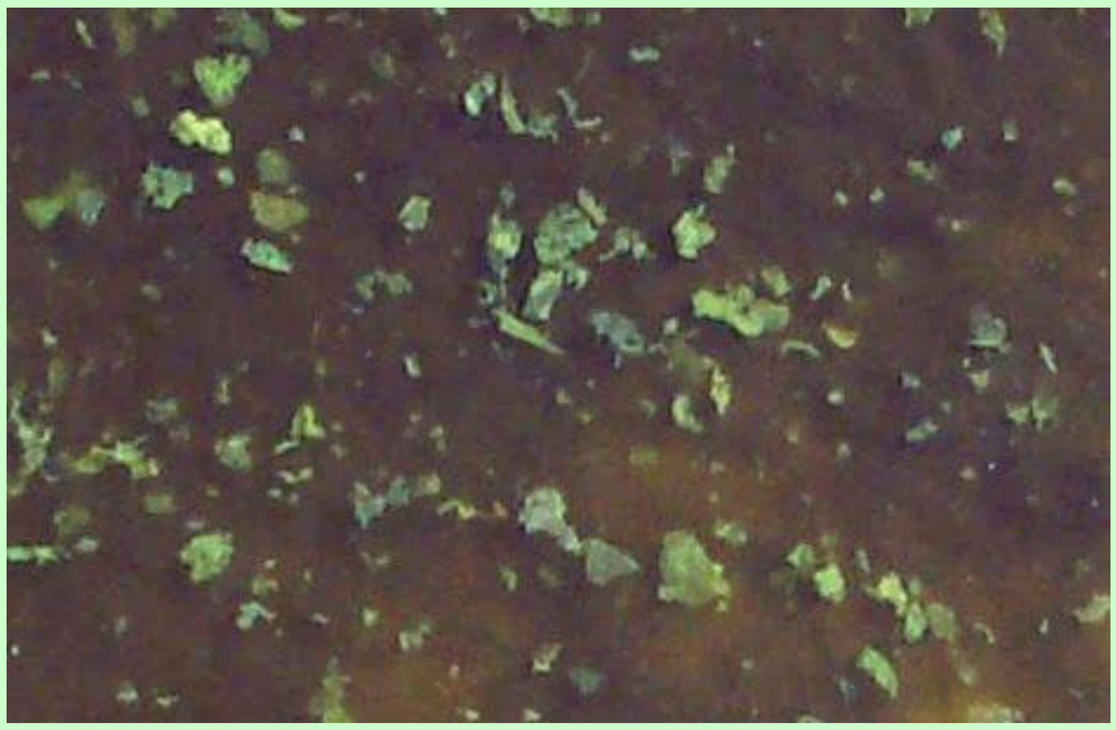
M. aeruginosa is a bloom-forming algae found primarily in freshwater eutrophic lakes and low salinity estuaries. In the San Francisco Estuary the bloom is characterized by green, irregularly shaped colonies, approximately one-eighth to two inches in diameter that float on or near the water surface.

M. aeruginosa is one of many algal species identified by the Environmental Monitoring Program in water samples collected from the San Francisco Estuary.







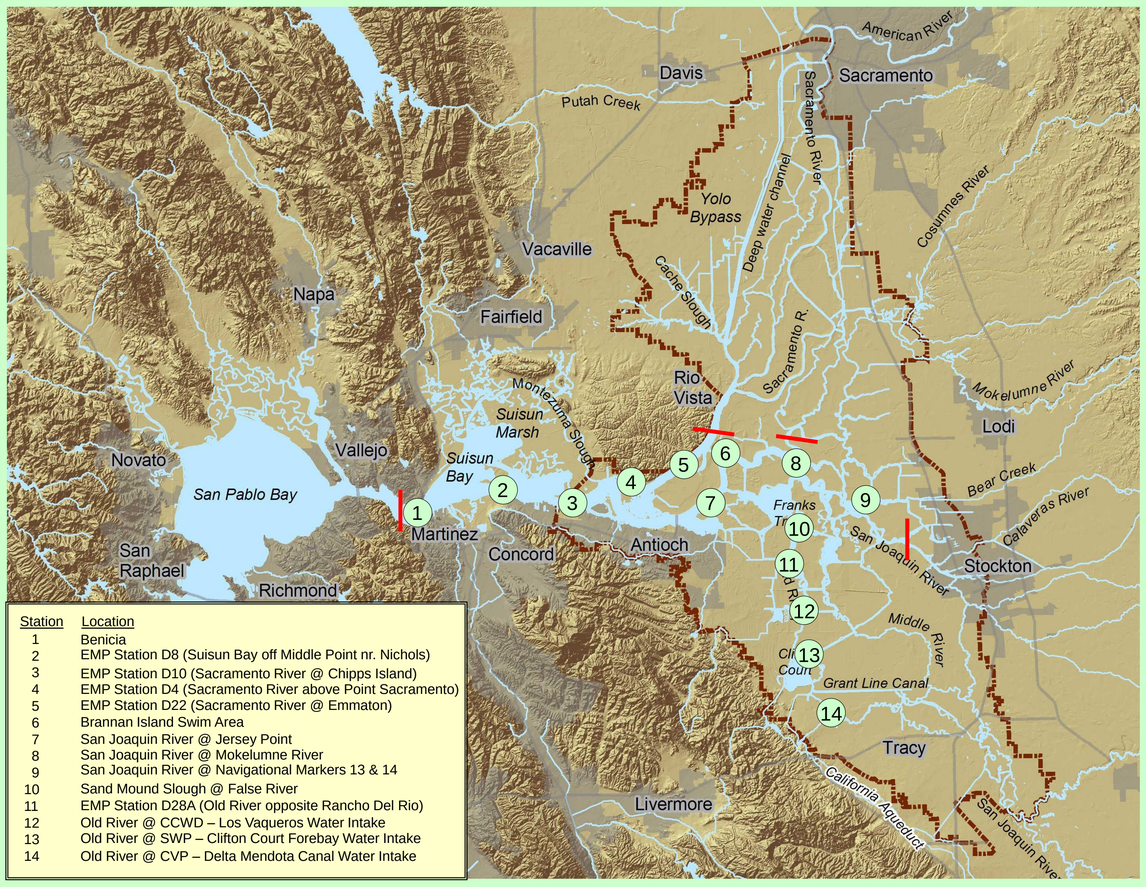


Why is it important to monitor Microcystis?

M. aeruginosa is sometimes characterized as a harmful algal bloom (HAB) species and could adversely impact the San Francisco Estuary. Blooms may contain hepatotoxic microcystins (liver toxins) which if ingested may pose a risk to human, wildlife and livestock health. Microcystins in drinking water are known to be harmful even at low concentrations and the cyanobacterial peptide toxins accumulate in certain aquatic food webs. Ingestion and/or contact of waters containing high concentrations of *M. aeruginosa* can cause gastrointestinal discomfort and minor skin irritation in humans. Long-term exposure to hepatotoxic microcystins in drinking water is associated with liver dysfunction.

http://dnr.metrokc.gov/wlr/waterres/lakes/bloom.htm

The potential adverse impacts of *M. aeruginosa* blooms to beneficial use in the Estuary are significant. The impacted region contains endangered fish species such as the native Delta smelt and fall run Chinook salmon. It is also a feeding ground for marine mammals such as seals and sea lions. The region is an important recreational area that includes sport fishing and water contact sports like water skiing. In addition, water from this region is used directly for drinking water and irrigation. High concentrations of *M. aeruginosa* could cause taste and odor problems and filter-clogging.



Station	Location
1	Benicia
2	EMP Station D8 (Suisun Bay off Middle Point nr. Nichols)
3	EMP Station D10 (Sacramento River @ Chipps Island)
4	EMP Station D4 (Sacramento River above Point Sacramento)
5	EMP Station D22 (Sacramento River @ Emmaton)
6	Brannan Island Swim Area
7	San Joaquin River @ Jersey Point
8	San Joaquin River @ Mokelumne River
9	San Joaquin River @ Navigational Markers 13 & 14
10	Sand Mound Slough @ False River
11	EMP Station D28A (Old River opposite Rancho Del Rio)
12	Old River @ CCWD – Los Vaqueros Water Intake
13	Old River @ SWP – Clifton Court Forebay Water Intake
14	Old River @ CVP – Delta Mendota Canal Water Intake

Identification of Affected Areas

The purpose of the first survey on September 12, 2003 was to establish the geographic extent (distribution) of *M. aeruginosa* throughout the upper San Francisco Estuary and to help develop *M. aeruginosa* monitoring strategies.

Collection methods for *M. aeruginosa* biomass in open water were evaluated using a Van Dorn water sampler, vertical net tow, and horizontal surface net tow. Because of the patchiness of the bloom the Van Dorn water sampler did collect representative samples of the cyanobacteria. The Van Dorn water sampler and vertical net tow often pushed cell material away and did not collect samples in relation to surface colonies which were observed. In addition, grab samples collected with the Van Dorn and vertical net tow did not collect large enough quantities of cell material required for toxicity testing. The horizontal tows conducted over a larger surface area gave the best quantitative and integrated sample of the bloom.

Visual observations were made at the water's surface and in areas along the shore to establish presence or absence of the alga and to make a general qualitative assessment of the concentration.

The study area represented a wide range of habitat types from marine water habitat at the western end of Suisun Bay to freshwater habitat upstream in the Sacramento, Old, and San Joaquin rivers. Widely-dispersed solitary colonies of *M. aeruginosa* were observed as far west as Benicia. The alga was also found as far north as the confluence of Three-mile Slough at the Sacramento River and near Rancho Marina in the Mokelumne River. Fairly dense colonies were found as far south as Old River near the Delta Mendota Canal. The blue-green alga was again found easterly in the San Joaquin River near Buckley Cove (EMP monitoring station P8). No *M. aeruginosa* colonies were observed at the water's surface in the Sacramento River west of Decker Island. Windy conditions (up to 8 knots) in this area may have distributed the alga further down in the water column. Sampling took place during a strong ebb tide (3.2 knots) which may have also affected distribution throughout the region.

Methods

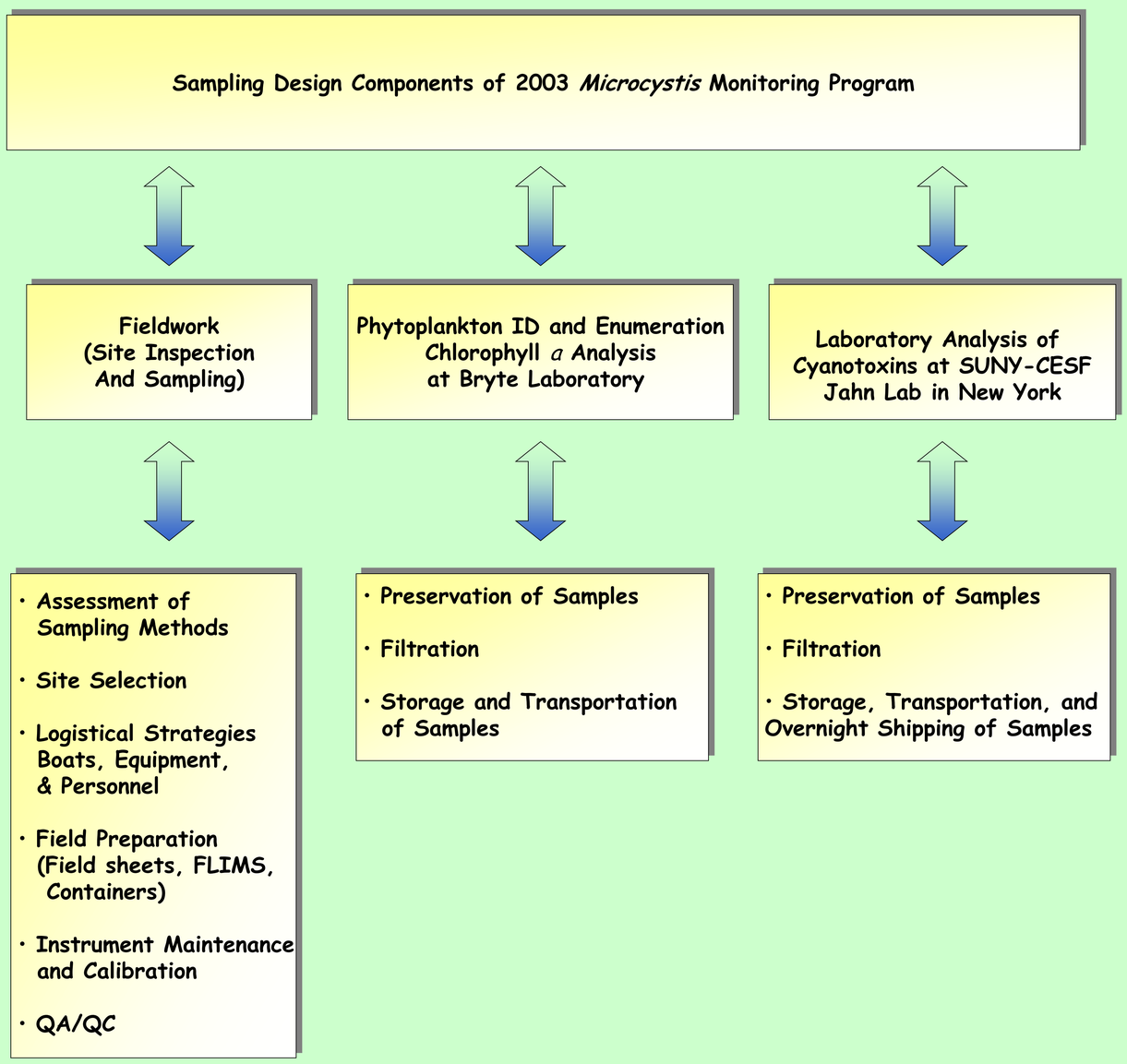
M. aeruginosa biomass and toxicity were sampled on October 15, 2003 at 14 stations representing different habitat types or use including recreational swimming, shallow water habitat, deep river channel, and agricultural and drinking water. Colonies were sampled by horizontal surface tows with a 0.72 m diameter plankton net fitted with a 75 μm mesh screen on the cod end. Sampling a large size fraction assured the sample primarily contained the colonial form of *M. aeruginosa*. Tows were conducted at the center of the channel at a speed of 60m/min and lasted 1 to 10 minutes. Horizontal tows were used to obtain a quantitative and integrated sample of the bloom which had a patchy distribution. Total volume of the sample was determined from an attached General Oceanics 2030R flowmeter. Water transparency was measured using a standard black-and-white Secchi disk (20 cm diameter). Water temperatures and specific conductance were measured at each station using a YSI 85 sonde.

The presence of microcystin in the food web was assessed by the presence of microcystin in animal tissue. Zooplankton were sampled at 5 stations by oblique net tows of a 0.7 m diameter plankton net fitted with a 150 μm mesh net on the cod end. Clams were obtained using a ponar dredge.

M. aeruginosa colonies > 75 μm diameter were present in surface samples at all stations sampled.

Analysis results will be discussed in Peggy Lehman's Poster: "Biomass and toxicity of the cyanobacteria bloom of *Microcystis aeruginosa* in the Delta".

A full description of the study is in press (Lehman, P.W. et al, 2005. Distribution and toxicity of a new colonial Microcystis aeruginosa bloom in the San Francisco Estuary, California., Hydrobiologia).



Summary

Specials studies conducted by the Environmental Monitoring Program in 2003 provided valuable information on the spatial distribution and toxicity of *M. aeruginosa* and methods for collecting and analyzing a patchy, surface floating alga. Based on the information and lessons learned from these studies a more comprehensive study was conducted in 2004. The purpose of the 2004 study was to quantify the seasonality of *M. aeruginosa* biomass, toxicity, and geographical extent based on bi-monthly sampling at 10 stations in the San Joaquin, Sacramento, Old, and Middle rivers. Physiochemical constituents: nutrient analysis, dissolved oxygen, pH, fluorescence, and turbidity were added to the 2004 study. Zooplankton and clam sampling was also conducted at some of the stations to determine the tissue toxicity potential impacts of *M. aeruginosa* on the food web.

Acknowledgements

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